IES Newsletter

Volume 16, Number 1
January - February 1999

Director's Note

My first trip to Chile was in 1990. A colleague at the University of Virginia and I had initiated the Global Precipitation Chemistry Project, to determine what factors regulate the chemical composition of rain and snow in areas remote from human influences. Since then I have been back several times, collaborating with scientific colleagues — IES adjunct scientist Dr. Juan Armesto, a forest ecologist at the Universidad de Chile in Santiago and Dr. Doris Soto, professor of aquatic ecology at the Universidad Austral de Chile in Puerto Montt, among others — and working with several of my graduate students on their thesis research.

Chile offers magnificent ecosystems and fascinating research opportunities. I am delighted to be continuing my work there, through the Cordillera Piuchué Ecosystem Study, and to be sharing that work with you, through the cover story of this issue of the *IES Newsletter.*

The *IES Newsletter* is published by the Institute of Ecosystem Studies, located at the Mary Flagler Cary Arboretum in Millbrook, New York.

Director: Gene E. Likens
Administrator: Joseph S. Warner
Head of Education: Alan R. Berkowitz
Newsletter editor: Jill Cadwallader

Address newsletter correspondence to the editor at:
Institute of Ecosystem Studies
Education Program, Box R
Millbrook NY 12545-0178
e-mail: CadwalladerJ@ecostudies.org

Printing: Central Press, Millbrook, N.Y.

Looking for Clues in Clouds Over Chile

These days it's not easy to find truly pristine environments — places unaffected by humans. Yet for scientists to understand the workings of ecological systems, ideally they must understand how such systems function in the absence of human influence. A team of ecologists, including a group from the Institute of Ecosystem Studies, has found such a place to do ecosystem research: the Cordillera de Piuchué on the island of Chiloé off the coast of Chile.

The temperate forests of southern Chile are as unpolluted as any that exist in the world today. These areas have not been exposed to significant human impacts, and they receive among the lowest nitrogen deposition* levels via rainwater anywhere. In addition, unlike many temperate forests in the Northern Hemisphere, they have remained floristically and climatically stable throughout the Holocene epoch (in geologic time, the last 10,000 years). Scientists believe this climatic stability may be due to the influence of westerly storm tracks that affect the area.

* *Nitrogen, primarily in the form of nitrate and ammonium, is carried through the atmosphere and delivered back to Earth through both wet deposition – in cloudwater, fogwater and precipitation – and dry deposition of gases and dry particles.*

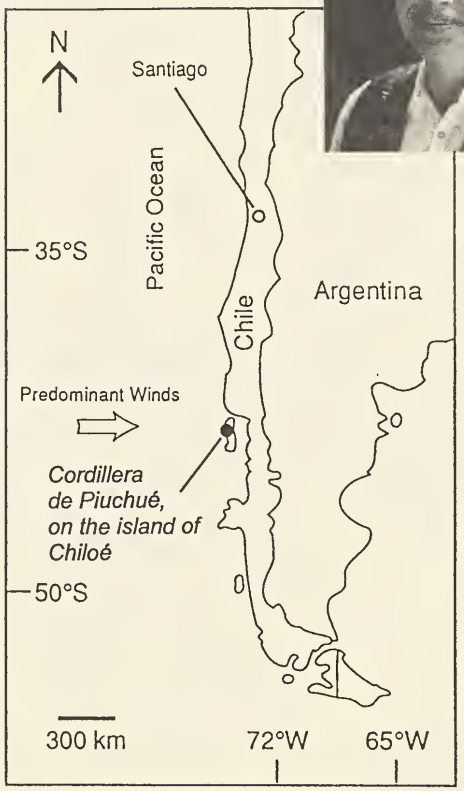
The Cordillera de Piuchué is a mountain range on the west side of Chiloé, located within the 45,000 hectare Chiloé National Park. Dr. Lars Hedin, after completing his doctoral research at IES, and IES adjunct scientist Dr. Juan Armesto (Universidad de Chile, Santiago) initiated a research program in Chiloé in the early 1990s, designed to evaluate general theories about nutrient cycling. Together with colleagues, they found that while much of existing biogeochemical theory was applicable to these unpolluted, stable old-growth forests, patterns of nitrogen cycling appeared to be more complex than the current thinking held: inputs and outputs, which should balance, did not. In a 1995 paper in the scientific journal *Ecology*, the scientists suggested that old-growth forests therefore might be particularly good sites to evaluate the links between inputs (atmospheric deposition) and what goes on within the ecosystem (internal cycling).

In 1997, the Andrew W. Mellon Foundation provided funding for a multidisciplinary team of scientists from the Institute of Ecosystem Studies and six universities to develop, as described in the program's prospectus, "a globally unique ecosystem study that provides 'a window to the past' — a rare view into the natural workings of a 'pre-industrial' temperate ecosystem". And so began a new era in the Cordillera Piuchué Ecosystem Study.

MOLLY AHEARN

Dr. Kathleen Weathers, (inset, left) a forest ecologist whose IES doctoral research demonstrated the role of cloudwater as a source of airborne pollutants, is the principal investigator of the Institute's portion of the study. In collaboration with Dr. Gary Lovett and IES Director Dr. Gene Likens, she is measuring cloudwater chemistry and nitrogen deposition, from atmosphere to forest floor, to try to understand as yet unexplainable irregularities in the nitrogen cycle. The team has established a meteorological station with cloudwater collector, and maintains rainfall and throughfall collectors; the latter collect rain and cloudwater after it has dripped through the forest canopy. Research assistant Lee Portnoff, working for IES and the University of Virginia — one of the collaborating institutions — maintains the cloud and rain collectors and the meteorological station, and collects the samples

continued on page 3



Map of southern South America showing study site, adapted from Hedin, Armesto and Johnson, 1995.

Ecology: The Science of Limits

by Steward T.A. Pickett

In an article in the previous issue of the newsletter (Vol. 15 No. 6), I complained about the claim made by the journal, *Science*, that the only ecological principle worthy of mentioning in a list of the top 20 ideas in all of science was the idea that "all life is connected." I suggested that differential connections — the fact that connections are often subtle, indirect, staggered through time, or varying from strong to weak — were far more interesting than simply that connections of some sort were universal. But I can't suggest that even the revised principle should be the sole representative of ecology in that hall of fame. I suspect that there is at least one more fundamental ecological idea that would better represent the discipline.

Before seeking the one idea to represent ecology, I should note that the task is difficult because ecology has such a broad scope. Ecologists study how the genetics of organisms change in response to physical and biological interactions. They also study how individual organisms fit into their environments, and what stresses and interactions control behavior. And they study groups of different organisms, focusing on how populations are distributed and limited, or how communities of plants and animals are assembled and change through time. But they don't even stop there: ecosystem ecologists, for example, study the fluxes of energy and matter through systems that are made up of both organisms and physical environments, and landscape ecologists study the spatial distributions of communities, ecosystems, or habitat types, and how those spatial patterns interact with the other processes of interest to ecologists.

Not only is ecology concerned with a wide range of phenomena, but it examines systems that are very small, and systems that are very large. A small system might be the population of microbes in a patch of soil organic matter, which function in decomposition. A large system is illustrated by the entire biosphere – all the living organisms on Earth, plus their products, and the physical materials they interact with.

The range of time spans covered by ecological studies is also large. Most ecological research examines processes that occur over a short time span, say within a year or a growing season. But ecology also examines the decades-long processes of plant community change, and the even longer changes resulting from natural climate cycles, or the ebb and flow of species over geological time. So, ecology is an amazingly diverse field. What single principle could apply to the whole gamut?

Perhaps the ecological principle that can apply to all of these realms, sizes, and lengths of time is the idea that no ecological system grows without limits. This generalization is a law of sorts, one that indicates that all ecological systems, whether they are organisms, populations, communities, ecosystems or elements of a landscape, have spatial and temporal limits. These limits are most readily seen in looking at organisms or at systems that are made up of organisms. The growth of any individual organism is limited by structural soundness and resource availability. The growth of a population is limited by physical stresses, space, resources, parasites, predators or other species on which it depends for mutual benefit. A graph of population increase always – except, so far, for humans – exhibits a cap. The expansion of ecosystems is limited by the costs of maintenance compared to the costs of growth, so that eventually the biological matter must stop accumulating at a particular place. In large landscapes, the spatial spread of a particular community type or habitat type is limited by biological or physical changes, such as natural disturbances or soil type. Hence, all landscape elements are bounded and limited.

What does this principle do in ecology? It doesn't explain everything about all systems, but it does indicate a general strategy for understanding ecological systems. The principle suggests that ecologists look for the structures and processes that drive growth or expansion of systems, but that they also look for processes, events, and structures that limit the growth of those systems. So ecologists are involved in discovering explanations for how the world works, in which they have to play off factors that increase size, scope or functioning of systems against factors that constrain the size, scope or function.

The principle also suggests that all other, more detailed and specific ecological explanations cannot violate the assumption of ecological limits. For instance, explaining how a particular organism deals with a specific stress can't assume that the organism will have unlimited pools of energy to draw on to meet the challenge. Or, in modeling the growth of productivity in a forest stand, an important task will be to determine what factors limit it, and how and when they operate. So the principle explains some observed ecological phenomena directly, but it indicates the general shape that any ecological explanation must take. Systems are expected to experience checks, constraints, negative feedbacks, and the like. Such constraints can either originate internally or externally to the place or system being observed.

Explanations in other disciplines that share some of ecology's scope may also illustrate the principle of limits. Evolutionary diversification is limited by the amount of genetic variation available in a population. And the core evolutionary process of natural selection works because there are limits to the number of organisms that can survive at a given place and time.

Taking ecology to be the "science of limits" may appear to be negative, but scientific principles are not intended as moral beacons. And there are positive ways to look at how ecological systems deal with limits. Operating within a complex web of constraint, ecological systems exhibit a staggering variety of responses to limits. The biological richness in species, communities, ecosystems, and landscapes shows the immense range of solutions to the ecological problem of dealing with limits. In fact, in an unlimited world (which we can only imagine with the greatest theoretical abandon), there would be little ecological variety. Limits are a big part of why we live in such a diverse and functionally flexible world. So perhaps a different, and seemingly more positive, principle should be the aforementioned 20th Big Idea of Science: "Ecological systems continually adjust to the changing physical and biological limits they experience."

It's not as poetic as saying that all life is connected, but there's more ecological reality in it. The poetry can come later.

IES Spring Plant Sale

Friday, May 21: 10 a.m. - 4 p.m.
Saturday, May 22: 10 a.m. - 4 p.m.
Sunday, May 23: 11 a.m. - 4 p.m.

For information, call:
914/677-5365

Mark your calendars now !!

Dr. Hogan Helps Develop New Ways to Analyze Science Instruction

Dr. Kathleen Hogan spent the month of November at the University of California at Los Angeles working on projects with colleagues in both the psychology and education departments. The purpose of her visit, supported by a grant from the National Science Foundation, was two-fold: to become familiar with new videotape data analysis software, and to help develop analysis procedures for a study under the auspices of the Third International Mathematics and Science Study (TIMSS). The study uses videotape samples of 8th grade math and science instruction from classrooms around the world to construct comparable models of pedagogy that can be related to worldwide student math and science achievement data. Dr. Hogan, an educational research and development specialist at IES, now is using these analysis techniques and tools in her own research in local middle school classrooms, where she studies students' scientific reasoning and their construction of ecological knowledge.

JEFF CHERRY

IES Course Fills a Gap in Campus Curriculum

MOLLY AHEARN

"Ecosystem Ecology" is a subject not commonly offered at colleges and universities. In response to a need first expressed by IES graduate students during the late 1980s, in 1989 the Institute offered its first Fundamentals of Ecosystem Ecology (FEE) course. This intensive, two-week intersession program proved to be so popular among master's and doctoral degree students nationwide that it has been given every other year since then. This January, thirteen students learned about ecosystem processes — primary and secondary production, biogeochemical cycling, food webs etc. — as well as a host of related topics including invasive species, species interactions, ecosystem engineering, ecosystem management and restoration and public policy. Sessions were taught by IES ecologists Michael Pace, who was also the course coordinator, Charles Canham, Nina Caraco, Jonathan Cole, Stuart Findlay, Peter Groffman, Clive Jones, Gene Likens, Gary Lovett, Richard Ostfeld, Steward Pickett, Richard Pouyat, David Strayer and Kathleen Weathers.

1999 FEE participants: Left to right, standing: Elena Bennett, U. of Wisconsin; David Senn, M.I.T.; Timon McPhearson, Rutgers U.; Jonah Smith, Rutgers U.; Brad Cardinale, U. of Maryland; Helen Thompson, Rutgers U.; Matt Palmer, Rutgers U.; Joy Ramstack, Lehigh U.; Feike Dijkstra, Wageningen Agricultural U., The Netherlands; Dina Leech, Lehigh U.; kneeling in foreground: Yoko Kato, Rutgers U.; Jennifer Johnson, Rutgers U.; Scot Zens, Dartmouth U.; Dr. Michael Pace, program coordinator, IES.

IES Ecology Camps

Winter into Spring Camp
April 6-9, 9 a.m. - 2 p.m.
Grades 4-6. Fee: $100
Registration deadline: March 15
How do plants and animals survive harsh winter conditions? How do they respond to the approach of spring?

Saturday Science Forest Ecology
6 Saturdays: April 17-May 22, 9 a.m. - noon
Grades 7-9. Fee: $90
Registration deadline: March 15
Investigate a fascinating forest food web through experiments, hiking and other nature activities.

Summer Ecology Day Camp
8 sessions from June 28 - August 20
Grades 2-4, 9 a.m. - 2 p.m.. Fee: $125
Grades 5-7, 9 a.m. - 4 p.m.. Fee: $175
Registration deadline: June 4
What lives in and around streams and ponds? How does the land affect the flow of water, and why do we care?

Summer Ecology Day Camp Junior Counselors
The IES Summer Ecology Day Camp needs 1 junior counselor for each week-long session (8 volunteers in all). Call Kris Desmarais (914/677-7644) for information. Application deadline: May 3.

To register for camp, call 914/677-7640.

Clues, *from page 1*

and ships them to IES and the Univ. of Virginia for chemical analysis. These data are indicating a surprisingly high concentration of nitrogen in cloudwater.

Does the extra nitrogen in cloudwater that is being deposited in the forests of Southern Chile come from ocean upwelling? Are the sources anthropogenic, such as from the burning of forests? Or could the excess arise from bacterial activity? Dr. Weathers is hoping to pursue the question of "Whence come the nutrients?" with Dr. Lovett and Dr. Nina Caraco, an IES biogeochemist, as this long-term international ecosystem study continues.

INSTITUTE OF
ECOSYSTEM STUDIES
Education Program
Box R
Millbrook, New York 12545-0178

Newsletter

Volume 16, Number 1
January - February 1999

Calendar

CONTINUING EDUCATION

For a **winter-spring 1999** catalogue and program information, call the Continuing Education office at 914/677-9643. Programs during March and April include:

Gardening

Mar. 6: **Trees: Landscape Uses, Selection and Planting**
Mar. 13: **Trees: Care and Maintenance**
Mar. 20: **Basic Cultural Techniques for Perennials**
Mar. 27: **What's in a Name? Understanding Botanical Names**
Apr. 8 (6 sessions): **Insect Pests and Diseases of Plants**
Apr. 10 (4): **Plants for the Landscape: Woody Plants**
Apr. 11: **Gardening with Deer**
Apr. 11: **The French Kitchen Garden in America**
Apr. 24: **Field Course: Managing Soils**

Landscape Design

Mar. 2 (8): **Landscape Design III**
Mar. 13: **Contour Plans**
Mar. 20 (3): **Inspired Residential Landscape Des.**
Mar. 24 (6): **Construction I**
Apr. 16(2): **A Professional Evaluation of Your Landscape**

Natural Science Illustration

Mar. 17-19: **Pen & Ink I**
Mar. 20-21: **Color Sketching in the Greenhouse**
Apr. 17-18: **Exploring Nature's Design**

Biology and Earth Science

Mar. 27: **Chinese Medicinal Botanicals**
Mar. 27: **Wildlife Habitat Management and Conservation**
Apr. 10: **Native American Healing Herbs**
Apr. 12: **In Search of Elusive Creatures: Amphibians and Reptiles**
Apr. 25: **Wild Plant Ident.: Early Spring**
Apr. 29(5): **Nature's Pharmacy: Herbal Remedies**

Workshops

Apr. 9: **Planting the Seeds of Your New Business**
Apr. 14: **Mini-Workshop: The Schoolyard — A Dynamic Resource**
Apr. 17: **Planting Design for Ponds and Other Wetlands**

Ecological Excursions

Mar. 15: **New England Flower Show**

IES SEMINARS

Free **scientific seminars** are held each Friday at 11:00 a.m. at the IES Auditorium.

Mar. 5: **Sex, Drugs, and Resistance: Hybridization and Plant-Herbivore Interactions**. Dr. Colin Orians, Tufts University
Mar. 12: **The Ecology of Beginning and Ending: Natural Hybridization in Animals**. Dr. Charles Lee Remington, Yale University
Mar. 19: **Nitrogen Pollution and Decline of Ectomycorrhizal Fungal Diversity: Where Have All the Mushrooms Gone?** Mr. Erik Lilleskov, Cornell University and IES
Mar. 26: **Scaling Up Simulation Model Estimates for Soil Trace Gas Emissions: Merging Ecological Data and Remote Sensing on Regional to Global Scales.** Dr. Christopher Potter, NASA Ames Research Center, California
Apr. 9: **Ecological Dynamics of Lyme Disease Risk**. Dr. Richard Ostfeld, IES
Apr. 16: **Transparency of Freshwaters to Solar UV Radiation: Environmental Variability and Regulation**. Dr. Donald P. Morris, Lehigh Univ.
Apr. 23: **Tropical Montane Cloud Forest in Xalapa, Mexico: Long-term Ecological Studies and Conservation**. Dr. Guadalupe Williams-Linera, Instituto de Ecologia, Xalapa, Mexico
Apr. 30: **To be announced**

GREENHOUSE

The IES greenhouse, a year-round tropical plant paradise and a site for controlled environmental research, is open until 3:30 p.m. daily except public holidays. Admission is by free permit (see HOURS).

IES ECOLOGY SHOP

New in the Shop ... IES sweatshirts ... 5th edition of *Woody Landscape Plants* by Michael Dirr ... terra-cotta windchimes ... **for children** ... animal finger puppets ... binoculars ... **and in the Plant Room** ... "Wormie" the water sensor ... plant markers and carbon pencils ... long-handled EZ diggers
Senior Citizens Days: 10% off on Wednesdays
•• **Gift Certificates** are available ••

VOLUNTEER OPPORTUNITIES

Current needs: Telephone reception, clerical work in the IES Education Program Office. For information, call Ms. Su Marcy at 914/677-7641.

HOURS

Winter hours: October 1 - March 31
Public attractions are open Mon. - Sat., 9 a.m.-4 p.m. & Sun. 1-4 p.m., with a free permit*.
(Note: The Greenhouse closes at 3:30 p.m. daily.)
The **IES Ecology Shop** is open Mon.- Fri., 11a.m.-4 p.m., Sat. 9 a.m.-4 p.m. & Sun. 1-4 p.m.
(The shop is closed weekdays from 1-1:30 p.m.)
** Free permits are required for visitors and are available at the IES Ecology Shop or the Education Program office daily until 3 p.m.*

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include subscription to the newsletter, member's rate for courses and excursions, a 10% discount on IES Ecology Shop purchases, and participation in a reciprocal admissions program. Individual membership: $30; family membership: $40. Call Ms. Janice Claiborne at 677-5343.

The Institute's Aldo Leopold Society
In addition to receiving the benefits listed above, members of The Aldo Leopold Society are invited guests at spring and fall IES science updates. Call Ms. Jan Mittan at 677-5343.

TO CONTACT IES ...

... for research, graduate opportunities, library and administration:
Institute of Ecosystem Studies
Box AB
Millbrook NY 12545-0129
Tel: 914/677-5343 • Fax: 914/677-5976
Street address: Plant Science Building, Route 44A, Millbrook, N.Y.

... for education, general information and the IES Ecology Shop:
Institute of Ecosystem Studies
Education Program, Box R
Millbrook NY 12545-0178
Tel: 914/677-5359 • Fax: 914/677-6455
IES Ecology Shop: 914/677-7649
Street address: Gifford House Visitor and Education Center, Route 44A, Millbrook, N.Y.

...IES website: www.ecostudies.org